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AN INVESTIGATION OF DISCRIMINATION LEARNING ABILITY IN MONGOLOID AND NORMAL CHILDREN OF COMPARABLE MENTAL AGE.

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THIS INQUIRY INVESTIGATED DISCRIMINATION LEARNING PROCESSES IN TRAINABLE MONGOLOID CHILDREN AS COMPARED WITH NORMAL PRESCHOOL CHILDREN. ITS PURPOSE WAS TO CONTRIBUTE TO GENERAL BEHAVIOR THEORY AND TO THE KNOWLEDGE OF MENTAL DEFICIENCY BY SEEING IF SUCH VARIABLES AS TRANSFER OF TRAINING, ACQUIRED DISTINCTIVENESS OF CUES, AND ACQUIRED EQUIVALENCE OF CUES KNOWN TO FACILITATE OR HARM LEARNING WOULD OPERATE IN A SIMILAR MANNER WITH NORMAL CHILDREN AND MONGOLOID DEFECTIVES. FOUR INDIVIDUAL STUDIES WERE CARRIED ON. THE FIRST EXPERIMENT WAS CONCERNED WITH THE ABILITY OF THE TWO GROUPS TO MAKE A RHYTHMIC DISCRIMINATION. THE SUBJECTS WERE ASKED TO DISTINGUISH BETWEEN PATTERNS PRODUCED BY METRONOMES BEATING AT TWO DIFFERENT SPEEDS. IN ADDITION, HALF THE SUBJECTS IN EACH GROUP WERE REQUIRED TO DUPLICATE THE PATTERNS, SO THAT THE EFFECTS OF THE RESULTING KINESTHETIC CUES COULD BE STUDIED. A SECOND EXPERIMENT INVOLVED THE ROLE OF "ATTENTION SETS" IN THE LEARNING OF A SIMPLE BUTTON PRESSING TASK. THE REMAINING STUDIES WERE CONCERNED WITH SIMILAR LEARNING PROBLEMS, WITH PARTICULAR ATTENTION BEING PAID TO THE ROLE OF "DISCRIMINATION SETS" AND VERBAL MEDIATION PROCESSES. BEHAVIORAL VARIABILITY WAS NOT NOTICEABLE IN THE INSTITUTIONALIZED MONGOLOIDS. THE STEREOTYPE OF A DOCILE, COMPLIANT, WELL-BEHAVED INDIVIDUAL DID NOT HOLD UP AMONG THE SPECIAL CLASS MONGOLOIDS. WHILE SOME OF THESE LATTER DID INDEED APPEAR TO CONFORM TO THIS EXPECTED PATTERN, OTHERS EVIDENCED BEHAVIOR WHICH COULD BE DESCRIBED AS HYPERACTIVE, HOSTILE, AND REBELLIOUS. THE COMPLEXITIES INTRODUCED INDICATED THAT IT WOULD BE WORTHWHILE TO CONTINUE THE UTILIZATION OF THIS COMPARATIVE APPROACH. (GC)

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January 1, 1957-June 30, 1958

Gordon N. Cantor, Project Director

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INTRODUCTION

This report summarizes four studies concerned with discriminative learning in mongoloid and normal children of comparable or roughly comparable mental age levels. Attention was focussed in each case on the relative performances of the two types of subject groups and also on various variables considered to be relevant in discrimination learning problems.*

The general goal of all four experiments was to study simple learning processes in a relatively homogeneous group of mental defectives and to evaluate the role played by several supposedly facilitative mechanisms in the learning of these defectives and of normal controls. A basic premise underlying the research is the notion that theory and eventual application in the area of learning can benefit from investigations that are concerned with simple, highly controlled situations and that take into account the individual difference variable of intelligence.

Study #1 has been published in the same form as that found herein in the American Journal of Mental Deficiency, 1959, 63, 621-625. Study #2 is based on a master's thesis submitted by Mr. Girardeau to the Graduate College of George Peabody College for Teachers. It is due to appear, in shortened and slightly altered form, in the Journal of Comparative and Physiological Psychology.

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*The term "discrimination learning" has been used in this report to refer to a variety of laboratory tasks calling for discriminative responses. Study #2 involved simple simultaneous discrimination learning - - the usual referent of the term. The criterion task in study #4 may perhaps be best thought of as requiring successive discrimination learning, whereas studies #1 and #3 actually involved simple forms of paired-associates learning.

Study #1

Rhythmic Discrimination Ability in Mongoloid and Normal Children

Gordon N. Cantor and Frederic L. Girardeau

A great deal of emphasis has been placed in recent years on the fact that mental defectives are not a homogeneous group of individuals. Even when fairly sharply defined and circumscribed sub-groups are considered (e.g., defectives falling within a given IQ range, defectives whose conditions are due to a specific etiological factor, etc.), marked heterogeneity is often apparent within these groups in terms of both physical and behavioral characteristics. Generalizations are still verbalized, however, which indicate that some defective subgroups do tend to be characterized to a significant extent by certain characteristics. Probably of no group is this more true than in the case of mongoloids. The physical similarity of full-blown mongoloids is well known and doubtless no one would quarrel with the validity of generalizations of this nature. Regarding mongoloid <u>behavioral</u> characteristics, however, many generalizations exist which are based on subjective judgments and which are in need of objective verification.

The present study is concerned with the notion that mongoloids have an unusual sensitivity with respect to rhythmic stimulation. Tredgold and Soddy (5, p. 302) refer in this connection to the "marked sense of rhythm" of the mongoloid. Wallin (7, p. 291) indicates in less strong terms that the typical mongoloid has a "fairly good sense of rhythm." Shuttleworth (4) referred to the mongoloid's "idea of time"

as "remarkable." Brushfield (2), in observing a group of 177 mongoloids, noted that all of them could hum a tune "correct in note and time."

Blacketer-Simmonds (1) performed a study in which, by questionnaire and testing techniques, an attempt was made to objectively evaluate several mongoloid behavioral characteristics. In studying responses to rhythmic stimulation, this investigator used 42 mongoloids and 42 matched non-mongoloid defectives. The Ss were exposed to three repetitions of three rhythmic patterns produced on a small drum. After each presentation, S was asked to reproduce the pattern. Eighteen mongoloids and 14 non-mongoloids were rated as evidencing a "good" sense of rhythm; the remaining Ss in each group were rated as showing "no sense of rhythm at all." The groups did not differ significantly in these respects. Similar results were obtained in various "timing" exercises (marching to music, bending to music, etc.).[1]

The task utilized in the present study required mongoloid and normal Ss to distinguish between sounds produced by metronomes beating at two different rates. Although such differential stimulation may not involve what the musician might regard in strict terms as differences in rhythmic patterns, it was decided that the technique was a desirable one for two reasons: (a) the stimuli and the responses made to them could be handled in a highly objective manner; and (b) it seemed reasonable to assume that the individual with a "marked sense

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[1]Negative results were also obtained with respect to several other mongoloid behavioral stereotypes investigated.

of rhythm" would achieve at a high level of proficiency on this task.

In addition to the ability of the two groups to perform on the metronome task, the role of kinesthetic cues was studied by requiring half of the Ss to tap in time with the metronome beats before each attempt at making a differential response.

It was expected that the mongoloids would achieve as well as normal preschool children and that those Ss forced to tap in time with the auditory stimuli would perform better than the Ss not forced to tap.

Method

Subjects.- Usable data were obtained on 44 mongoloids enrolled in trainable classes in 12 Tennessee communities and on 24 normals from the Peabody College Demonstration Preschool. Originally, 48 mongoloids with MA's of 3-0 or more (1937 Stanford-Binet, Form L) had been chosen for the study. A total of 59 such mongoloids had to be run, however, to obtain 44 usable scores. The 15 Ss whose data were not used failed to cooperate with E or could not pronounce the two required response words clearly enough for E to distinguish them reliably. Half the Ss in each group were assigned to a "Tapping Group" (TG) and half to a "No-Tapping Group" (N-TG). Originally, these assignments had been made by means of a table of random numbers. For the additional mongoloids run, a coin flipping procedure was utilized to complete this assignment of Ss to the sub-groups. The characteristics of the four sub-groups are shown in Table 1.

Table 1

Characteristics of the Four Sub-Groups

Group	N	CA (mo.)		MA (mo.)*		IQ*	
		Mean	SD	Mean	SD	Mean	SD
Mongoloid-TG	22	146.41	35.49	53.18	12.53	37.45	9.09
Mongoloid-N-TG	22	148.59	41.06	51.59	9.66	37.27	6.53
Normal-TG	12	56.25	3.74	64.92	8.07	115.42	12.07
Normal-N-TG	12	55.83	4.67	66.17	6.82	119.00	14.22

*1937 Stanford-Binet, Form L

Apparatus.- The materials used were two Seth Thomas metronomes (No. 7, Cat. No. 1101) and a flat black shield large enough to hide the metronomes from S's view.

Procedure.- The metronomes were placed behind the shield with one immediately in back of the other so that location cues were minimized and E could manipulate the metronomes without being observed by S. Each S was run individually. One metronome was set at 120 beats per min., the other at 88 beats per min. These rates were given the labels "fast" and "slow", respectively. Initially, S was exposed to 20 beats of the metronome at each of the rates. The No-Tapping Ss were merely asked to listen, while the Tapping Ss were required to tap with one finger on the table at which they sat. For all Ss, E recited the name of the rate during the 20 beats and instructed S to repeat the name. If E could not clearly distinguish S's two responses, the experiment was terminated for that child. No normal S was eliminated. Fifteen mongoloids were eliminated - - seven because of speech difficulties, eight due to lack of cooperation. Following the initial

indentification of the two rates, 60 presentations of the stimuli were given - - 30 at each of the two rates. The rates were presented in a pre-arranged, non-alternating fashion. A single presentation constituted a trial and involved eight beats. At the end of each trial, S was asked to identify the rate by responding "fast" or "slow". The E said, "That's right" if S responded correctly, and "No, that was fast (slow)" if the response was incorrect. The E made no comments if the Tapping Ss failed to keep reasonably good time with the metronome beats, but did instruct these Ss to keep tapping whenever they stopped during the course of any given trial. Between trials, the Tapping Ss were reminded to tap in time with the metronome beats if they had shown negligence in this respect on the previous trial, or if their hands were not in position at the start of a new trial.

The criterion measure was the number of correct responses in 60 trials.

Results

As can be seen from Table 1, the mongoloids had an average CA of about 12 yr., 4 mo. and were very heterogeneous with respect to CA. The normals averaged about 4 yr., 8 mo. and constituted a very homogeneous age group. The average IQ for the mongoloids was 37.36, whereas the normals averaged 117.21. It had been hoped that the mongoloids and normals would be comparable in MA, but this did not turn out to be the case. A factorial analysis of variance design (3, ch. 9) applied to the MA data of the four sub-groups indicated that the normals (mean MA= 5 yr.,

6 mo.) were significantly higher in MA than were the mongoloids (mean MA= 4 yr., 4 mo.). The Tapping Group was not significantly different from the No-Tapping Group in MA, and there was no significant interaction between type of S and type of treatment so far as MA level is concerned.

Table 2 shows the results on the metronome task for the four sub-groups and Table 3 the results of a factorial analysis of variance design applied to these data.

Table 2

Performance of the Four Sub-Groups on the Criterion Task

Group	Mean	SD
Mongoloid - TG	33.14	8.17
Mongoloid - N-TG	35.68	11.72
Normal - TG	40.33	10.26
Normal - N-TG	44.75	11.55

Table 3

Summary of Analysis of Variance of the Criterion Task Data

Source	df	Mean Sq.	F
Mongoloid vs. Normal	1	1027.09	9.51*
Tapping vs. No-Tapping	1	174.72	1.62
Interaction	1	13.60	.13
Error	64	108.04	

*P<.01

As indicated in Tables 2 and 3, the normals did significantly better than the mongoloids. There was no significant

difference between the Tapping and No-Tapping Groups and also no significant interaction between type of S and type of treatment

The possibility of utilizing analysis of covariance in order to perform an analysis with the data adjusted for the MA level difference was examined and had to be rejected. As indicated in Table 4, the assumption of homogeneity of regression could not be met.

Table 4

Pearson r Correlations between Criterion Score and MA for the Four Sub-Groups

Group	r
Mongoloid - TG	+.31
Mongoloid - N-TG	+.23
Normal - TG	+.27
Normal - N-TG	+.73*

*P<.05

Each S's performance was analyzed to determine if the proportion of correct responses made by that individual departed significantly from what might be expected by chance (i.e., from P = .50 or 30/60 correct responses). A large sample test concerning proportions (6, p. 67) was used for this purpose.[2] The .05 level was used to reject the hypothesis of chance behavior. The results of these analyses are seen in Table 5.

[2]The N for each of these tests was 60 (i.e., the number of trials). The formula utilized was $z = p-P/\sqrt{PQ/N}$, where p= the obtained proportion of correct responses for each S and P= .50.

Table 5

Frequency and Percent of Chance and Non-Chance Performances in the Mongoloid and Normal Groups*

Group	Better than Chance		Chance		Worse than Chance	
	N	%	N	%	N	%
Mongoloid	14	32	26	59	4	9
Normal	16	67	7	29	1	4

*"Chance" behavior is defined as 30/60 correct responses. Each S's obtained score was evaluated by means of the formula cited in footnote 2 to ascertain if the score fell above, below, or in the range of scores that statistically could be considered as due to "chance" at the .05 level of significance. The frequencies of Ss in the mongoloid and normal groups who fell in these three classes are presented above.

In order to examine the question of whether the performances of the mongoloid and normal groups as a whole departed significantly from chance (i.e., from 30/60 correct responses), the hypothesis that the $\bar{z}$'s (obtained from the previously described analyses) do not differ from zero (i.e., chance) was tested. The $\bar{z}$ value for the mongoloids was +1.21. A t of 2.88 (df=43) indicates that this value is significantly different from zero at the .01 level of significance. The normals' $\bar{z}$ value was +3.49. This is also significantly different from zero, the obtained t of 5.63 (df=23) again being significant at the .01 level.

Discussion

Although the mongoloids as a group performed better than would be expected by chance, their performance was significantly inferior to that of the normals. That psychological as well as

statistical significance is involved in this latter comparison is attested by the differential proportions of the two groups performing at chance and non-chance levels (see Table 5). Empirical questions which are raised by the results include the following: (a) how would the mongoloid group's performance compare with that of a non-mongoloid defective group of comparable MA level? and (b) how would their performance compare with that of normals whose MA level is more nearly comparable to that of the mongoloids?

It is unfortunate that the normals were significantly higher than the mongoloids in MA level. The results must be interpreted in light of this discrepancy. Nevertheless, it would seem to be of some interest that the mongoloids (aver. age 12 yr., 4 mo.) could not perform as well as four- and five-year-old regular class preschoolers. There appear to be no grounds for explaining the substantial correlation obtained between MA level and performance in the case of just one of the four sub-groups.

The finding that attempts to tap in time with the metronome beats did not facilitate discrimination performance contradicts the S-R assumption that the additional cues provided by this behavior would make the stimulus complexes more discriminable. The E's observation that few Ss in either the mongoloid or normal group were able to tap in reasonably good time indicates that the motor activity was actually too difficult for the Ss and served as an interfering rather than a facilitative mechanism.

The results would seem to indicate that, in the absence of

objective evidence to the contrary, the trainable mongoloid cannot be said to be characterized by a "marked" sense of rhythm.

Summary

Forty-four mongoloids (aver. CA = 12 yr., 4 mo.; aver. MA = 4 yr., 4 mo.) and 24 normals (aver. CA = 4 yr., 8 mo.; aver. MA = 5 yr., 6 mo.) were exposed to 60 presentations of eight metronome beats, 30 at a rate of 120 beats per min. ("fast") and 30 at 88 beats per min. ("slow"). Half of each group of Ss were required to tap with the metronome beats. The S's task was to identify each stimulus presentation by means of the proper label.

Both the mongoloids and normals as groups did significantly better than would be expected by chance (i.e., 30/60 correct responses), but the normals significantly exceeded the mongoloids in performance. This finding must be interpreted in light of the fact that the normal group had an MA level significantly above that of the mongoloid group. The presence or absence of tapping had no significant effect on performance.

The results call into question the commonly expressed generalization that mongoloids are characterized by a "marked" sense of rhythm.

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Study #2

The Formation of Discrimination Learning Sets in Mongoloid and Normal Children

Frederic L. Girardeau

Considerable attention has been paid in the past several years to the empirical phenomenon described by Harlow (5) as "learning set." Data from several studies (5, 8, 12, 15, 16) have indicated that rats, monkeys, and chimpanzees form discrimination learning sets which are qualitatively similar. Quantitative differences observed between species (14) and between normal and operated monkeys (7) indicate that groups which differ in learning ability may exhibit quantitative differences in the formation of learning sets.

Adams (1) has obtained evidence for the formation of learning sets in human adult males. Kuenne (5), Hayes, Thompson, and Hayes (9), and Shepard (17) have demonstrated that preschool children show progressive improvement in performance on a series of discrimination problems. Roberts, in a descriptive study reported by Harlow (6), observed no difference between the performances of normal and orphanage children on a series of discrimination problems.

There is little information available on the formation of learning sets in mentally retarded subjects. Barnett and Cantor (2) have shown that mental retardates improve in performance on a discrimination problem as a result of prior training on a similar problem. Ellis (3) has demonstrated the formation of learning sets in two groups of mental retardates. A high MA

group formed sets more efficiently than did a low MA group. House and Zeaman (10) found that 14 mentally retarded children in the imbecile range (mean IQ=28, mean MA=3 yr., 6 mo.) failed to form learning sets over a series of 60 discrimination problems, although the objects within each pair differed multidimensionally. In comparing the learning set performances of six normal and eight mentally retarded children (IQ range 50 to 75), Kaufman and Peterson (11) concluded that "normal children exhibit a tendency to make more correct responses than retarded children on 48 object-quality problems." A significantly greater percentage of stimulus-perseveration errors was made by the retarded group, which did not include clinical types such as mongoloids.

The present study was concerned with the ability of mongoloid and normal children of the same MA to learn discrimination problems in which the stimuli differed only slightly in form. The study was further designed to investigate the formation of discrimination learning sets and to evaluate the relationship of IQ to the formation of such sets.

Method

Subjects.- Nine mongoloids from the State Colony and Training School, Pineville, La., one mongoloid from Clover Bottom Home, Donelson, Tenn., and one mongoloid from a nursery school in Nashville, Tenn. were used as Ss. One S was eliminated from this group because of illness incurred during the third intersession interval. The remaining ten Ss constitute the group labeled "mongoloid."

Seventeen children from the Peabody College Demonstration

Preschool were used as normal Ss. Seven of these Ss were eliminated - - one for failure to learn Problem 1, one for lack of cocperation on Problem 1, and five because of illness incurred during intersession intervals. The remaining ten Ss constitute the group labeled "normal".

There were eight male and two female Ss in each group. The characteristics of the two groups are given in Table 1. None of the Ss revealed any visual defect, either by superficial examination or from case history records. None of the Ss had had prior experience with discrimination learning problems. In comparing the mongoloid and normal groups for MA level, a t of .84 was obtained, which was nonsignificant at the .05 level.

Table 1

Characteristics of the Two Groups

Group	N	Measure	CA (mo.)	MA (mo.)[a]	IQ[a]
Mongoloid	10	Range	79-252	49-78	28-63
		Mean	192.70	61.70	38.80
		SD	51.01	13.53	10.02
Normal	10	Range	50-63	51-82	96-136
		Mean	57.00	66.00	115.90
		SD	4.43	8.97	13.31

[a]1937 Stanford-Binet, Form L

Apparatus.- The stimuli consisted of ten wooden objects arranged in five pairs, the positive stimulus for each pair being determined by a coin flipping procedure. The problems are presented diagrammatically in Fig. 1. In the selection of stimuli

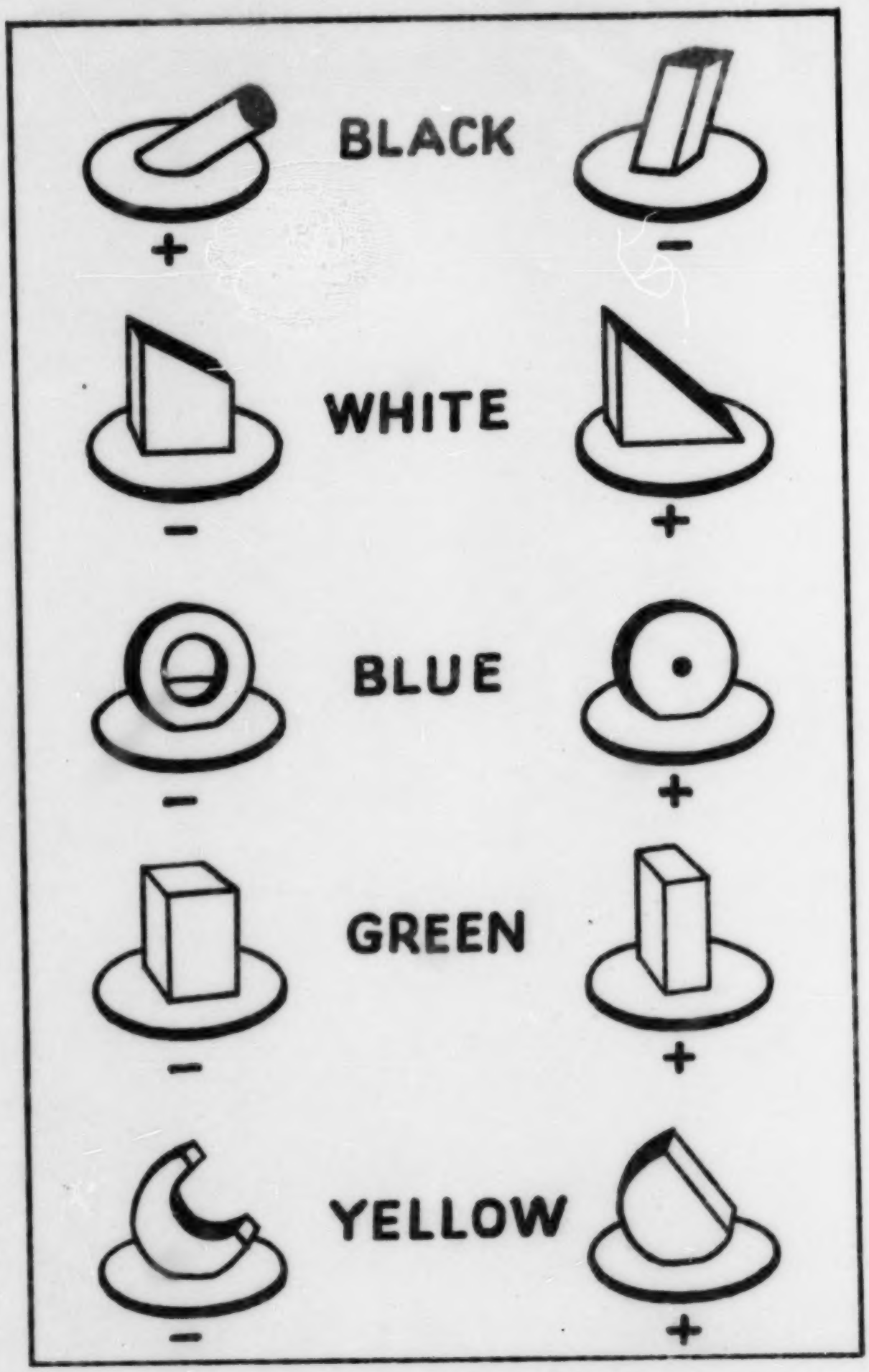

Fig. 1. Discrimination problems, indicating the color and positive stimulus of each problem.

and arrangement into pairs, care was taken to maximize stimulus similarity within a problem and to minimize stimulus similarity between problems. There were interproblem differences in form, size, and color. Form was the only intraproblem difference.

The apparatus on which the stimuli were presented consisted of a wooden box painted flat black and measuring 18 in. x 14 in. x 5 in. Token rewards were placed in one of two round, shallow depressions on top of the apparatus. The base of each stimulus covered the shallow depression. A wooden shield painted flat black was used as a screen between trials.

Procedure.- Twenty-four hours prior to the beginning of discrimination training on the experimental problems, E and S looked at magazines together for approximately 12 minutes to familiarize S with E and the experimental room. Then S was given a "warm-up" task to acquaint him with the type of manipulations involved in the experimental problems. In the "warm-up" task, S was instructed to pick up one of three identical aluminum jello molds to find a token reward.

For the discrimination training sessions, S was seated in front of the apparatus. The shield was removed and instructions were given to find the token reward. The S was told that although the stimuli would be in different positions, the token reward would be under the same block every time. Each S was further told that if he found "enough" token rewards, he could select one of 13 final rewards, which included inexpensive toys, candy, and crackers. After giving the instructions, E replaced the shield, arranged the stimuli, and placed a token reward under

the positive stimulus. The shield was then lifted by E in such a manner that E was hidden from S; S made a response and then E lowered the shield. All trials proceeded in the same manner. A non-correction procedure was used for all trials. For each problem, the positive stimulus was the same for all Ss. The left-right relationships of the positive and negative stimuli for the various trials were determined in a prearranged, non-alternating fashion. Each problem was continued until S made 11 successive correct responses. Fifty trials was the maximum number run in an experimental session. If S failed to reach criterion on a problem in 50 trials, training was resumed on that same problem at the next experimental session, with the end of one day and the beginning of the next counted as a continuous series of responses. Failure to learn a problem was defined as inability of S to attain the criterion of 11 successive correct responses in 300 trials. Only one problem was presented in any experimental session. An experimental session constituted discrimination training on a problem until the criterion was reached or until the maximum number of trials allowed in a session (i.e., 50) had been run.

The first three experimental sessions were on consecutive days, with approximately a 24 hour intersession interval. There was a 72 hour intersession interval between the third and fourth experimental sessions. The remaining sessions were on consecutive days, with the same 24 hour intersession interval. Eight experimental sessions was the maximum taken by any S to complete the five problems.

Experimental design.- The five problems were arranged in five arbitrarily chosen sequences to partially counterbalance for order of problem difficulty. Initially, the ten Ss in each group were assigned randomly to the five sequences, two Ss from each group to each sequence. Additional Ss needed to replace lost Ss were assigned to various sequences so that ultimately two Ss from each group were assigned to one of the five sequences of problems. All Ss received the same five problems.

A 2 x 5 x 5 Lindquist Type III mixed design (13) was used, with mongoloid group vs. normal group as one variable (Groups), ordinal number of problem as a second variable (Problems), and sequence of problems as the third variable (Sequences). The number of trials to criterion on each problem was used as the criterion score for the analysis of variance.

Results

The performances of the two groups on the series of problems are summarized in Table 2 and Fig. 2. The data show that both the normal and mongoloid groups improved in their ability to solve the discrimination problems, although the best performance for both groups occurred by Problem 3.

Table 2

Trials to Criterion for the Two Groups on the Series of Problems

Group	Measure	Problems 1	2	3	4	5
Mongoloid	Mean	58.90	44.00	17.00	18.60	18.40
	SD	37.32	32.09	10.00	9.25	7.62
Normal	Mean	33.10	13.10	11.80	13.60	12.40
	SD	16.57	3.64	.79	7.53	1.71

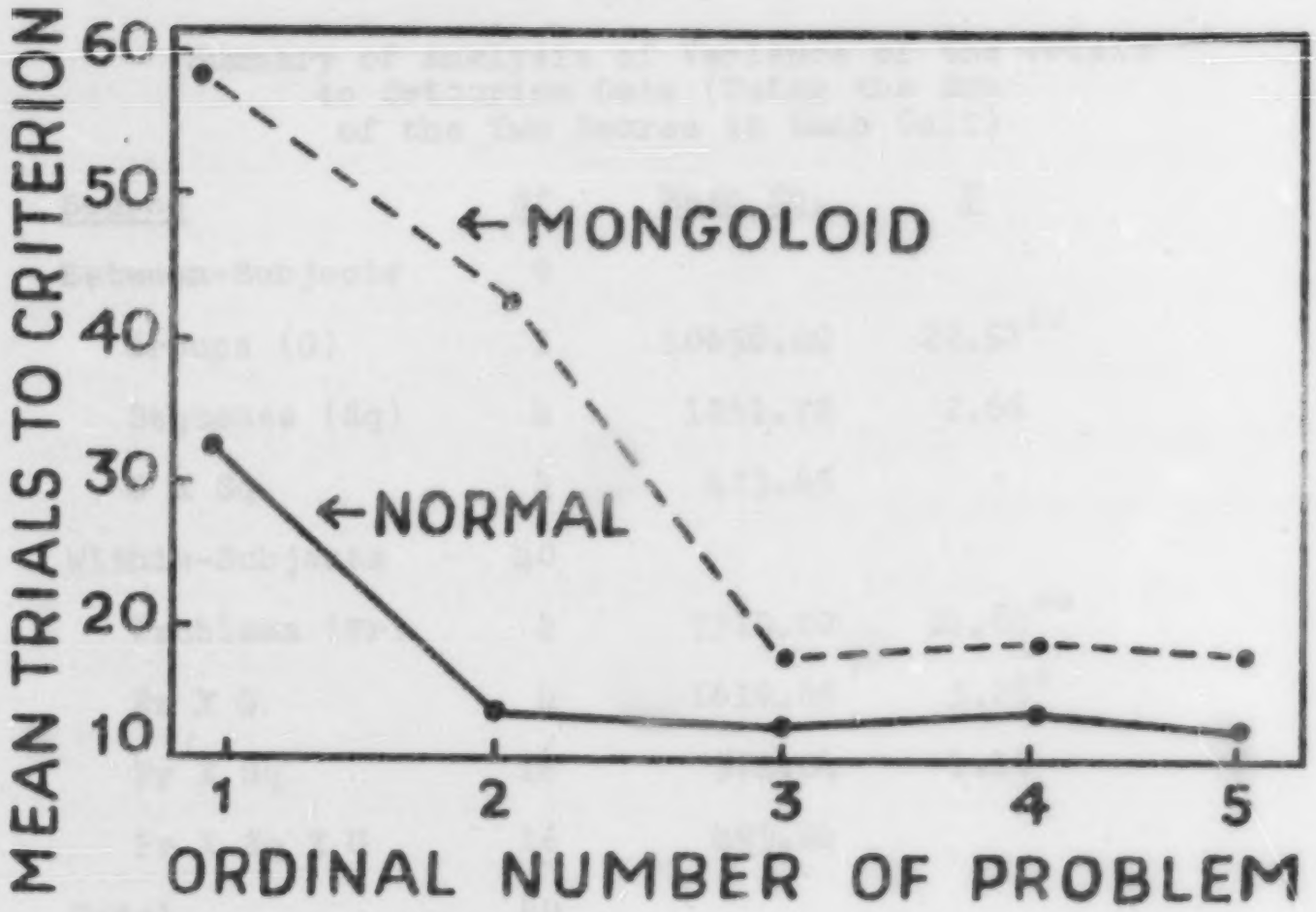

Fig. 2. Mean trials to criterion for the mongoloid and normal groups.

The performance of the normal group exceeds that of the mongoloid group on every problem. The results of the analysis of variance are summarized in Table 3.

Table 3

Summary of Analysis of Variance of the Trials to Criterion Data (Using the Sum of the Two Scores in Each Cell)

Source	df	Mean Sq.	F
Between-Subjects	9		
Groups (G)	1	10658.00	22.51**
Sequence (Sq)	4	1261.72	2.66
G X Sq	4	473.65	
Within-Subjects	40		
Problems (Pr)	4	7310.02	14.82**
Pr X G	4	1619.65	3.28*
Pr X Sq	16	572.04	1.16
Pr X Sq X G	16	493.24	
Total	49		

*P<.05
**P<.01

Because of the extreme heterogeneity of variances in the cells, the sum of the two scores in each cell was used for the analysis. Under this condition, the mean square for triple interaction was used as the error term in testing the Problems effect and also the double interaction effects involving within-subjects comparisons. The assumption was made that the Problems X Groups X Sequence interaction was nonsignificant.

The significant Problems X Groups interaction indicates

that the patterns of improvement for the mongoloid and normal groups were not the same. The Problems X Sequence interaction was not significant. For the between-subjects comparisons, the Groups X Sequence interaction mean square was used as the error term, the assumption being made that this interaction was nonsignificant. The Sequence effect was not significant.

In view of the significant interaction between Problems and Groups, it became necessary to examine group differences on each problem. The results of these comparisons are presented in Table 4. A significant difference in performance between the mongoloid and normal groups was found on Problem 2 ($t=3.03$, $df=9$, $P<.02$) and Problem 5 ($t=2.43$, $df=10$, $P<.05$). There was no significant difference between the groups on Problems 1, 3, and 4. Approximate t tests were used for the comparisons on Problems 1, 2, 3, and 5, since homogeneity of variance was not found between the two groups on these problems.

Table 4

Comparisons of the Mean Trials to Criterion of the Mongoloid and Normal Groups on Each Problem

Problem	df	t
1	13	2.01[a]
2	9	3.03[a**]
3	9	1.64[a]
4	18	1.33
5	10	2.43[a*]

[a]Approximate t
*P<.05
**P<.02

In order to determine where significant improvement in performance occurred, comparisons were made between various problems for each group. The t tests computed between the Problem means for each group separately are presented in Table 5. The results of the t tests indicate that the mongoloid group showed significant improvement in performance between Problem 1 and Problem 3 ($t=3.64$, $df=9$, $P<.01$) and between Problem 2 and Problem 3 ($t=2.57$, $df=9$, $P<.05$). For the mongoloid group, there was no significant difference in performance between Problems 1 and 2, 3 and 4, and 4 and 5. The normal group showed significant improvement between Problem 1 and Problem 2 ($t=4.00$, $df=9$, $P<.01$) and between Problem 1 and Problem 3 ($t=4.15$, $df=9$, $P<.01$). No significant differences were found between Problems 2 and 3, 3 and 4, and 4 and 5 for the normal group.

Table 5

Comparisons of Differences in Performance between Problems for the Mongoloid and Normal Groups

Group	Comparisons	df	t
Mongoloid	Problem 1 vs. 2	9	1.01
	Problem 1 vs. 3	9	3.64**
	Problem 2 vs. 3	9	2.57*
	Problem 3 vs. 4	9	-.56
	Problem 4 vs. 5	9	.07
Normal	Problem 1 vs. 2	9	4.00**
	Problem 1 vs. 3	9	4.15**
	Problem 2 vs. 3	9	1.14
	Problem 3 vs. 4	9	-.76
	Problem 4 vs. 5	9	.64

*P<.05
**P<.01

In order to determine where the significant Problems X Groups interaction occurred, a difference score was computed for each individual between successive pairs of problems and then difference score means were calculated for each group. The differences between the difference means of each group were then tested (i.e., the mean differences between Problems 1 and 2, 2 and 3, 3 and 4, and 4 and 5 for the normal group were compared with the mean differences between Problems 1 and 2, 2 and 3, 3 and 4, and 4 and 5 for the mongoloid group, respectively). Table 6 shows the results of these analyses.

Table 6

Comparisons of the Mean Differences of the Mongoloid and Normal Groups for Successive Pairs of Problems

Comparisons	Mean Difference		SD		df	t
	Mongoloid	Normal	Mongoloid	Normal		
Problem 1 vs. 2	14.90	19.90	46.54	15.74	12	.32[a]
Problem 2 vs. 3	27.00	1.30	33.17	3.59	9	2.44[a]*
Problem 3 vs. 4	-1.60	-1.80	9.09	7.51	18	.05
Problem 4 vs. 5	.20	1.20	9.23	5.94	18	.29

[a]Approximate t
*P<.05

The only significant difference between the mongoloid and normal difference means occurred in the performances on Problems 2 and 3 ($t=2.44$, $df=9$, $P<.05$).

Discussion

The results clearly indicate that both the mongoloid and normal groups improved in performance over the series of problems. The demonstration in the two groups of the formation of discrimination learning sets is consistent with the findings of previous investigators who have used both subhuman and human subjects, with the exception of the study by House and Zeaman (10) which indicated that imbeciles (mean IQ=28) do not form learning sets. A possible explanation of the differential findings lies in the fact that House and Zeaman's Ss started at a high level of performance and had very little room for improvement. An alternative explanation is that House and Zeaman used Ss with a mean MA of 3 yr., 6 mo., whereas the Ss used in this study had a mean MA of 5 yr., 2 mo.

It will be recalled that, in the analysis of variance, the triple interaction and the Problems X Sequence interaction were assumed to be nonsignificant and were used as error terms. There was no a priori reason to expect an interaction of Sequences and the other variables. If, however, these interactions actually were significant, the error terms employed in the F tests were inflated estimates of the appropriate error terms and rendered conservative the various tests of significance.

It is important to note that the normal group reached near-perfect performance (11.5 trials to criterion constitute perfect performance) on Problem 2. Thus, a "floor" effect operated for the normals which ruled out subsequent improvement. The significant Groups X Problems interaction can be explained

by the fact that the normals could no longer improve and that the mongoloids could and did improve. In order to rule out such an effect, it would be necessary to use problems in which neither group reached near-perfect performance so rapidly.

Although the performance of the normals exceeded that of the mongoloids on every problem, there were no significant differences between the two groups on Problems 1, 3, and 4. In view of the significant differnce on Problem 5, it seems reasonable to account for the nonsignificant differences in terms of the small number of Ss and the large variability in the groups (see Table 1).

The normal group was significantly superior to the mongoloid group on Problems 2 and 5 (see Table 4) and the other observed differences were in favor of the normal group, even though the groups were comparable in MA. This finding indicates that groups with different intelligence levels may differ quantitatively in their ability to form discrimination learning sets. Hence, observed differences in the learning behavior of individuals with identical MA's but different CA's (thus different IQ's) may be attributed in part to the difference in IQ. It follows that a more adequate description of behavior would be obtained by giving consideration to the IQ level as well as MA, a practice which has not been rigidly followed.

One explanation of the superiority of the normals could lie in the possibility that the intelligence of the two groups is composed of different factors. Even though the groups were comparable in MA, the factors which go to make up the normals'

MA scores may differ from those which make up the mongoloids' MA scores. A study by Thompson and Magaret (18) supports such an explanation. These investigators, studying differential test responses of normals and mental defectives on the Revised Stanford-Binet, Form L, found that the items which were more difficult for defectives than for normals of equal MA were those which were more heavily saturated with the common first factor extracted by McNemar. They concluded that this finding supported the view that the test performance of defective subjects is qualitatively different from that of normal subjects of equal MA. Also, Garrett (4) has contended that abstract or symbolic intelligence changes in its organization, as CA increases, from a fairly amorphous general ability into a group of fairly distinct aptitudes. Thus, it can be argued that the younger, normal subjects used in the present study possessed more general intellectual ability than the older, mongoloid subjects of the same MA and that the greater general ability of the normals was responsible for their superiority in the formation of discrimination learning sets.

Another important finding involved the significant improvement in performance from Problem 1 to 2 for the normal group and the nonsignificant improvement between these problems for the mongoloid group (see Table 5). The mongoloids, however, did improve significantly between Problems 2 and 3. Thus, it seems reasonable to infer that more problems are needed for mongoloids to show significant improvement as compared with normal children of the same MA.

Summary

An experiment was conducted to investigate the formation of discrimination learning sets in mongoloid and normal children of comparable MA's. Following a preliminary warm-up phase, ten mongoloids and ten normals were trained to a criterion of 11 successive correct responses on each of five form discrimination problems. The problems were partially counterbalanced for order of presentation. Only one problem was given at any one experimental session and 50 trials was the maximum given during one session. If the S failed to reach criterion, training was resumed on the same problem in succeeding experimental sessions until S reached criterion or received 300 trials.

Analysis of the group performances showed that both the mongoloid and normal Ss improved on successively presented discrimination problems. A Lindquist Type III mixed design was used, with mongoloids vs. normals as one variable (Groups), ordinal number of problem as a second variable (Problems), and sequence of problems as the third variable (Sequences). The analysis of variance resulted in a significant Groups X Problems interaction at the .05 level of significance. A series of t tests showed the performance of the normal group to be significantly superior to that of the mongoloid group on Problems 2 and 5. The differences in favor of the normal group on Problems 1, 3, and 4 were nonsignificant. These findings call into question the use of the MA concept as an adequate description of the learning ability of an individual and focus attention on a consideration of the IQ, as well as MA, as an important predictor

of learning behavior, a practice which has not been rigidly followed. It was suggested that the superior performance of normal children over mongoloids of the same MA may be due to the presence of greater general ability in the younger normals. An additional finding indicated that the mongoloid requires more problems to form learning sets than does the normal child of the same MA.

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Study #3

Transfer of a Discriminative Response Along a Difficulty Continuum in Mongoloids and Normals of Comparable MA

Gordon N. Cantor and Frederic L. Girardeau

Recent research has indicated that, under certain circumstances, a discrimination learning task can be more readily mastered if the subject first receives experience on a comparable but easier discrimination problem. Such studies have shown that subjects who are trained on an easier task and then shifted to a more difficult one do better on the latter than do control subjects who are trained throughout on the more difficult problem.

Lawrence (2), in training rats on a brightness discrimination problem, gave equal numbers of training trials to two groups; one group of subjects was trained on an easy brightness discrimination task and then shifted to a more difficult problem, whereas a second group received the latter problem throughout training. Lawrence found superior performance on the difficult task for the rats first trained on the easier discrimination. In a theoretical discussion of these findings (3), Lawrence raises questions concerning the applicability of current principles of stimulus generalization to such transfer phenomena.

In a report of a study still in progress, House, Zeaman, Orlando, and Fischer (1) describe the application of Lawrence's findings to some research on discrimination learning in imbeciles. One group of defectives was trained to discriminate three-dimensional objects differing in form and color; these

Ss were then given a discrimination task involving one-dimensional pattern reproductions of the three-dimensional objects. This group was labeled the "$\underline{O}_1$ to $\underline{P}_1$" group (object to identical pattern). A second group received training just on the one-dimensional stimuli and was referred to as the "$\underline{P}_1$" group (pattern).[1] With the data only partially collected, House et al., found the $\underline{O}_1$ to $\underline{P}_1$ group performing significantly better than the $\underline{P}_1$ Ss on the one-dimensional (pattern stimuli) task.

The findings of Lawrence and of House et al., focus attention on two important considerations, one theoretical and one practical: (1) theoretically, the results appear to require a re-examination of current notions about the nature of generalization gradients; and (2) from a practical standpoint, the data indicate that teachers involved in training children on fairly complex discriminations could more economically spend their time by first exposing the learners to simpler discrimination tasks bearing some resemblance to the complex problem.

The present study investigated the pitch discrimination ability of mongoloids and normals of comparable MA level, with particular attention being paid to the sort of transfer phenomenon described above. The questions posed were: (1) would Ss trained on an "easy" pitch discrimination task do better on a "hard" task than Ss trained throughout on the "hard" task? and (2) if this predicted transfer effect occurred, would it

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[1] A third group was treated as were the Ss in the $\underline{O}_1$ to $\underline{P}_1$ group, except that they were trained on a different set of 3-dimensional stimuli. This was referred to as the "$\underline{O}_2$ to $\underline{P}_1$" group (object to different pattern). For the purposes of the present report, this third group can be ignored.

be equally characteristic of the performances of mongoloids and normals of the same MA level?

Method

Subjects.- The Ss were 30 mongoloid and 30 normal children of comparable MA level. The mongoloids were patients or students from the Pineville, La. State Colony and Training School, the Fairhaven School, Atlanta, Ga., and the special classes of Murfreesboro, Tenn. The mongoloids had an average CA of 13 yr., 2 mo., an average MA of 5 yr., 0 mo., and an average IQ of 43.14 (Revised Stanford-Binet, Form L). The normals were drawn from four nursery schools in Nashville, Tenn. Their average CA was 4 yr., 11 mo., their average MA 5 yr., 0 mo., and their average IQ 102.34 (Revised Stanford-Binet, Form L).

Apparatus.- The apparatus consisted of a Type 1304-B Beat Frequency Audio Generator (General Radio Co.), a Model AA-902 Pilot Amplifier (Radio Corp.), and a Lansing D130 speaker enclosed in a Bradford 15U speaker cabinet.

Experimental design.- The mongoloids and normals were randomly assigned to two groups - - an "Easy-Hard" (E-H) and a "Hard-Hard" (H-H) group. The characteristics of the four resulting sub-groups are presented in Table 1.

Table 1

Characteristics of the Four Sub-Groups

Measure	Group							
	E-H Normals		H-H Normals		E-H Mongoloids		H-H Mongoloids	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CA (mo.)	58.00	6.18	59.67	8.10	167.47	55.43	148.33	47.65
MA (mo.)*	60.00	8.39	59.80	8.54	60.42	8.04	58.68	12.89
IQ*	103.80	14.07	100.87	11.54	42.67	11.37	43.60	9.00

*Revised Stanford-Binet, Form L

The experiment was divided into two parts - - a training and a transfer phase. On the basis of pilot work done on mongoloid children at the Louisa School, Murfreesboro, Tenn., two pairs of pure tone auditory stimuli to be produced on the audio generator were chosen. The pilot work indicated that two discriminations, one more difficult than the other, were within the mongoloids' discrimination capacity if a sufficient number of discrimination learning trials were given them. That is, with sufficient practice, the pilot mongoloids demonstrated that they could reliably distinguish between the members of each of these pairs of stimuli. The pure tone discriminations selected were 400 cps. vs. 600 cps. ("Easy") and 450 cps. vs. 550 cps. ("Hard").

In the <u>training</u> phase of the experiment, two sub-groups - - the E-H Mongoloids and the E-H Normals - - were given 20 trials of discrimination learning with the "Easy" (400 vs. 600 cps.) pair of stimuli; the remaining two sub-groups - - the H-H Mongoloids and H-H Normals - - were given 20 trials of the same type of training with the "Hard" (450 vs. 550 cps.) pair of stimuli.

In the <u>transfer</u> phase, the E-H groups were shifted without warning to the "Hard" (450 vs. 550 cps.) pair of stimuli and were given 30 trials with these stimuli. The H-H groups were merely continued for an additional 30 trials with the "Hard" stimulus pair. Thus, the H-H groups received a total of 50 trials with the "Hard" stimulus pair, the first 20 trials arbitrarily being designated as "Training" and the latter 30 trials as "Transfer." The E-H groups were given 20 trials with the

"Easy" stimuli and then 30 trials with the "Hard" stimuli, the former designated as "Training" and the latter as "Transfer" experience. The only difference between the E-H and H-H groups involved the stimuli used in the "Training" phase.

Procedure.- The Ss were run individually. Each S was brought into the experimental room and was told that he was going to "play a game." The following instructions were given:

> I want you to listen to some sounds. Listen to this (E sounded the high frequency tone of the training phase-- 550 cps. for the H-H groups, 600 cps. for the E-H groups-- and had S say "high" twice during the 30 sec. period the tone remained on). Now listen to this (E sounded the low frequency tone of the training phase-- 450 cps. for the H-H groups, 400 cps. for the E-H groups-- and had S say "Low" twice during the 30 sec. period the tone remained on). Now I'm going to make the sounds and you tell me if it's high or low. Everybody makes mistakes, so don't worry if you get it wrong; just tell me what you think it is and try to get it right. Ready now, listen.

Each S was then given the 20 trials of the training phase (ten "high" and ten "low" stimuli of approximately eight sec. duration, in a semi-random, non-alternating order) and then the 30 trials of the transfer phase (15 "high" and 15 "low" stimuli of approximately eight sec. duration, in a semi-random, non-alternating order). When S responded correctly to a given stimulus, E said, "Good, that's right." When S's response was incorrect, E corrected him. If S had not responded within a reasonable time after the presentation of the stimulus, E asked, "Which sound was that?"

Results

Table 2 presents the results on the transfer phase for the four sub-groups. It will be recalled that 30 trials were given in this phase and that the criterion measure was the number of correct responses in 30 trials. A chance score would equal 15.

Table 2

Number of Correct Responses on the Transfer Phase

Group	Measure	
	Mean	SD
E-H Normals	19.33	5.67
H-H Normals	18.80	6.69
E-H Mongoloids	18.73	6.14
H-H Mongoloids	16.13	4.76

A factorial analysis of variance design (4, p. 207) was run on these data and is summarized in Table 3.

Table 3

Summary of Analysis of Variance - - Transfer Phase Data

Source	df	Mean Sq.	F	$F_{.05}$
E-H vs. H-H	1	36.82	1.07	4.02
Normals vs. Mongoloids	1	40.02	1.17	4.02
Interaction	1	16.01	<1.00	4.02
Error	56	34.29		
Total	59			

As indicated in Table 3, the main effect involving the "Easy-Hard" and "Hard-Hard" treatments was non-significant, as were the difference between the types of subject (i.e., mongoloid vs. normal) and the interaction between these two main

effects. These uniformly negative results, together with the small discrepancy of each sub-group mean from a chance score of 15, suggest that perhaps the stimulus pairs (the so-called "Easy" and "Hard" pairs) were both actually too hard for the mongoloid and normal Ss used in the experiment. In order to investigate this possibility, various analyses were run and these are described in the remainder of the present section.

Table 4 shows the mean number of correct responses for the four sub-groups on the 20 trials of the training phase. A chance score here would involve ten correct responses.

Table 4

Number of Correct Responses on the Training Phase

Group	Measure	
	Mean	SD
E-H Normals	13.00	2.95
H-H Normals	12.20	3.90
E-H Mongoloids	12.80	3.65
H-H Mongoloids	10.00	3.50

Table 5 presents the results of a factorial analysis of variance design applied to the training phase data.

Table 5

Summary of Analysis of Variance - - Training Phase Data

Source	df	Mean Sq.	F	$F_{.05}$
E-H vs. H-H	1	33.75	2.73	4.02
Normals vs. Mongoloids	1	12.15	<1.00	4.02
Interaction	1	7.35	<1.00	4.02
Error	56	12.36		
Total	59	745.65		

Tables 4 and 5 indicate that, although the highest mean scores were obtained by the two E-H sub-groups, there was no statistically significant difference between any of the groups. This indicates that the two discriminations were actually not differentially difficult and that the designations "Easy" and "Hard" are inappropriate in this context.

The proportion of correct responses in the training phase out of a total of 20 possible correct was computed for each individual subject. Using a large sample test concerning proportions ($z = p-P/\sqrt{PQ/N}$) (5, p. 67), each individual's score was analyzed to see if it deviated significantly from chance.[2] The results are summarized in Table 6.

Table 6

Frequency of Chance and Non-Chance Behavior of Members of the Four Sub-Groups on the Training Phase

Group	Better than Chance	Chance	Worse than Chance
	N	N	N
E-H Normal	4	11	0
H-H Normal	5	10	0
E-H Mongoloid	5	10	0
H-H Mongoloid	2	13	0

In order to see if the sub-groups as a whole deviated significantly from chance, $\bar{z}$'s were computed for the four groups and t tests were run to test the hypothesis that the $\bar{z}$'s did not differ significantly from zero (i.e., chance). The results are summarized in Table 7.

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[2] The logic involved in this and subsequent analyses has been described previously in this report. See study #1, pp. 8-9.

Table 7

Results of Tests for Deviation from Chance Performance for the Four Sub-Groups as a Whole - - Training Phase

Group	$\bar{z}$	s_z	t	df	P
E-H Normal	1.36	1.34	3.93	14	<.05
H-H Normal	1.00	1.77	2.19	14	>.05
E-H Mongoloid	1.27	1.66	2.96	14	<.05
H-H Mongoloid	.27	1.59	.30	14	>.05

It can be seen in Table 6 that a majority of Ss in each of the sub-groups failed to exceed chance performance on the training phase. Only the E-H Normals and the E-H Mongoloids, as groups, performed at better than chance level (see Table 7).

A similar set of analyses was performed on the data for the transfer phase. Summaries of the results of these analyses are found in Tables 8 and 9.

Table 8

Frequency of Chance and Non-Chance Behavior of Members of the Four Sub-Groups on the Transfer Phase

Group	Better than Chance	Chance	Worse than Chance
	N	N	N
E-H Normal	5	10	0
H-H Normal	6	9	0
E-H Mongoloid	6	9	0
H-H Mongoloid	2	13	0

Table 9

Results of T-ests for Deviation from Chance Performance for the Four Sub-Groups as a Whole - - Transfer Phase

Group	$\bar{E}$	$s_{\bar{E}}$	t	df	P
E-H Normal	1.61	2.09	2.98	14	<.05
H-H Normal	1.41	2.48	2.20	14	>.05
E-H Mongoloid	1.39	2.26	2.38	14	>.05
H-H Mongoloid	.43	1.77	.94	14	>.05

Again, as indicated in Table 8, a majority of Ss in each sub-group failed to exceed chance performance on the transfer phase. Only the E-H Normal Ss, as a group, performed at better than a chance level in this phase of the experiment (see Table 9).

Discussion

The major findings of this study - - i.e., the lack of a significant difference between the E-H and H-H groups and also between the mongoloid and normal Ss on the transfer phase - - must be interpreted in the light of the findings summarized in Tables 4, 5, 6, 7, 8, and 9. These findings indicate that the so-called "easy" discrimination (400 vs. 600 cps.) and the so-called "hard" discrimination (450 vs. 550 cps.) were both actually "hard" (and equally so) for the Ss in this experiment. Specifically, this conclusion is substantiated by the following facts: (1) in the 20 trials of the training phase, the two groups given the "easy" discrimination did not significantly exceed the two groups given the "hard" discrimination; (2) in both phases of the experiment, a majority of the Ss in

each sub-group performed at no better than a chance level.

In view of the pilot work which indicated that mongoloid Ss from the Louisa School (Murfreesboro, Tenn.) could learn both of these discriminations (the 400-600 cps. pair more easily than the 450-550 cps. pair), it must be concluded that the pilot Ss used were not comparable in learning ability to the Ss eventually used in the experiment proper.

Because of the inappropriateness of the difficulty level of the discriminations chosen, it cannot be concluded that, under appropriate circumstances, the E-H treatment would not prove to be superior to the H-H treatment. The only fair test of this hypothesis would involve the use of pairs of stimuli which, objectively speaking, have indeed been shown to be "easy" and "hard," at least relatively speaking. Nor can one conclude that normals and mongoloids of the same MA level are comparable in pitch discrimination ability. Use of easier discriminations might have revealed differences in the performances of these two types of Ss.

The results point up the need for utilizing pilot Ss who come from the same population as do the experimental Ss. Further, the study focusses attention on the need for normative information concerning the ability of children (both defective and normal) to make pitch discriminations involving various cps. differentials.[3]

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[3]A search of the literature for such information was made prior to the start of the present study, but no relevant data could be found.

Summary

The purpose of this study was to compare the pitch discrimination ability of mongoloid and normal children of comparable MA levels. In addition, questions were raised regarding whether training on an "easy" discrimination would lead to better performance on a "hard" discrimination than would training on the "hard" discrimination throughout, and whether this would be equally true for the normal and mongoloid Ss.

Thirty mongoloids (mean CA=13-2, mean MA=5-0, mean IQ=43) and 30 normals (mean CA=4-11, mean MA=5-0, mean IQ=102) were divided into two sub-groups, called the "Easy-Hard" (E-H) and "Hard-Hard" (H-H) groups. The E-H sub-groups were given 20 training trials in which they were asked to learn the name "Low" to a 400 cps. pure tone and "High" to a 600 cps. tone. This 400-600 cps. discrimination was referred to as the "Easy" discrimination. This training was followed by the administration of 30 additional trials (transfer phase) in which a 450 cps. vs. 550 cps. discrimination was utilized, the S in this phase being asked to respond "Low" to the 450 cps. tone and "High" to the 550 cps. tone. The 450-550 cps. discrimination was referred to as the "Hard" discrimination. The H-H Ss were given 50 trials with the 450 cps. vs. 550 cps. discrimination. The first 20 of these trials for the H-H Ss were arbitrarily referred to as the "training" phase, the latter 30 as the "transfer" phase. Thus, the design allowed for a comparison of four sub-groups - - E-H Normals, H-H Normals, E-H Mongoloids, and H-H Mongoloids - - on 30 trials involving the "Hard"

discrimination (transfer phase), the E-H Ss having previously been given 20 training trials involving the "Easy" discrimination, the H-H Ss having previously been given 20 "training" trials on the "Hard" discrimination.

An analysis of variance design applied to the transfer phase data revealed no difference between the E-H and H-H groups, no difference between the Mongoloids and Normals, and no interaction between these two variables. Extensive analyses of the training and transfer phase data indicated that the two pairs of stimuli - - the so-called "Easy" and "Hard" discriminations - - were actually both <u>too hard</u> for the Ss used in this experiment. Because of the inappropriateness of the stimuli utilized, it was concluded that nothing could be said regarding the efficacy of the E-H training or the relative abilities of the Mongoloid and Normal Ss to make pitch discriminations.

Attention was focussed on the need for running pilot Ss drawn from the experimental population when such Ss are used to arrive at decisions regarding appropriate difficulty level of stimuli. Also, the need for normative information regarding the pitch discrimination abilities of defective and normal children was emphasized.

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Study #1

Learning of a Psychomotor Task in Mongoloids and Normals of the Same MA as a Function of Verbal Pretraining

Gordon N. Cantor

In recent years, psychologists working within the framework of S-R theory have tended more and more frequently to make use of the concept of "mediation." The general notion involved here is that the organism's responses (both overt and covert) have stimulus properties which can become linked up with subsequent responses. If one assumes that the organism does make covert responses and that these responses have stimulus properties, it becomes possible to account for "purposeful" or "foresightful" behavior, even in sub-human organisms, without being inconsistent with the assumptions of S-R theory. With reference to human behavior, the mediation hypothesis provides a convenient S-R avenue for analyses of "thinking" processes. The mediation notion is not a new one; Hull (4, 5) used the concept in some of his early discussions of maze learning. More recently, such workers as Spence (9) and Osgood (8) have utilized mediation hypotheses quite centrally in their theorizing.

A variety of predictions based on mediation theory can be made about human behavior. Miller (7), for example, postulated that if one learns names (labels) for stimuli, implicit naming responses and their attending stimuli will play an important role in facilitating subsequent learning involving these stimuli (as, e.g., when the individual must learn to make different motor responses to the stimuli). Numerous studies investigating this and similar problems have been done in recent years.

Arnoult (1) and Spiker (10), among others, have summarized the work in the area. A study by Cantor and Hottel (3) has shown that one of the mediation phenomena demonstrated in the behavior of normal humans can also be seen to operate in the behavior of mental defectives.

In one of the clearest demonstrations of the utility of the mediation hypothesis, Bugelski and Scharlock (2) presented college students with a series of three paired-associates verbal learning tasks involving four lists of nonsense syllables, these lists for present purposes being labeled "A", "B", "C", and "D". Ss in the experimental group first learned paired-associates involving lists A and B; this was followed by the learning of pairs involving lists B and C; this, in turn, was followed by the learning of pairs from lists A and C. The experimental treatment may thus be referred to as involving an A-B, B-C, A-C paradigm. The control Ss were given a similar learning experience, but the paradigm describing their task was of an A-B, B-D, A-C nature. It was predicted, on the basis of mediation theory, that the experimental Ss would perform better on the third (A-C) task than would the controls. The hypothesis underlying this prediction was that the experimental Ss, when faced with the A-C task, would implicitly respond with list-B syllables in response to the list-A syllables, in a manner consistent with their training on the first (A-B) task. The stimuli generated by the implicit "B" responses should then, so the argument continues, elicit "C" responses consistent with the learning that occurred on the second (B-C) task. Thus, the S would respond with the desired "C" syllables

in response to the various "A" syllables, due at least in part to the mediation process just described. Because of the break in the verbal chain for the control Ss (use of the B-D rather than the B-C list), a comparable facilitative effect would not be expected in their learning of the A-C list. The results of the experiment confirmed these expectations.

Since experiments such as the one just described provide a means for objectively studying the process we refer to in ordinary language as "thinking," it seems important that investigations of this nature be carried out on mentally defective Ss. The present study involved an attempt to compare mongoloid and normal Ss of the same MA with reference to mediated behavior. A group of mongoloid and a group of normal Ss were given a verbal pretraining experience (labeled "relevant") designed to provide mediating verbal responses that would be of utility in a subsequently presented motor task. Comparable groups of mongoloids and normals were given the same motor task, but for these Ss the task was preceded by verbal pretraining (labeled "irrelevant") not designed to provide subsequently useful mediating responses. It was predicted that, for both the mongoloids and normals, the relevant pretraining would lead to superior performance compared with that following irrelevant pretraining, and that the difference would be larger for the normal than for the mongoloid Ss (i.e., there would be a significant interaction between type of subject and type of pretraining).

Method

Subjects.- A total of 30 mongoloid and 27 normal Ss participated in the experiment. For reasons to be indicated later, the data for six mongoloids and seven normals were discarded, leaving 24 mongoloids and 20 normals. Half of each of these latter groups of Ss was assigned at random to a "Relevant" (experimental) group, the other half to an "Irrelevant" (control) group. The characteristics of the four resulting sub-groups are shown in Table 1.

Table 1

Characteristics of the Four Sub-Groups

Group	CA(mo.)		MA(mo.)*		IQ*		N
	Mean	SD	Mean	SD	Mean	SD	
Mongoloid-Relevant	257.58	49.10	61.25	8.51	33.67	3.39	12
Mongoloid-Irrelevant	241.92	51.99	64.33	8.22	36.17	4.34	12
Normal-Relevant	65.70	8.03	66.20	7.07	101.20	10.34	10
Normal-Irrelevant	65.30	10.83	64.20	7.86	99.30	7.30	10

*Revised Stanford-Binet, Form L

A factorial analysis of variance design (6, p. 207) applied to the MA data indicated that the four sub-groups were comparable in MA level. The mongoloid Ss were patients in three New York State institutions - - 14 from Letchworth Village, 7 from Willowbrook State School, and 3 from Wassaic State School. The normals were drawn from three nursery schools in Nashville, Tenn.

Apparatus.- Four decks of cards were used in the experiment, three of the decks consisting of plastic cards measuring 6 1/4 x 3 1/2 in., the remaining deck involving standard 3 x 5 in.

cards. Deck #1 was used to test for color naming ability and consisted of four plastic cards. On each of these cards were four rectangles measuring 1 1/2 x 1 in. - - one blue, one red, one yellow, and one green. The color patches were arranged in a different order on each card and consisted of strips of Scotch Brand Pressure Sensitive Tape mounted on the cards.[1] Deck #2 involved 30 3 x 5 in. cards - - 15 with an arrow pointing "up", 15 with an arrow pointing "down"; these cards served a dual purpose, being used to test for arrow naming ability ("up" and "down") at the start of the experiment and also as the stimuli in the transfer task, to be described later. Deck #3 consisted of 30 plastic cards on which were mounted pairs of stimuli placed side by side. Fifteen of the cards had an arrow pointing "up" on the left and a red patch on the right, while the remaining 15 had an arrow pointing "down" on the left and a blue patch on the right. This deck was used for the "relevant" pretraining. Deck #4 was used for the "irrelevant" pretraining and was identical to deck #3 with the exception that arrows pointing "up" were paired with green color patches and arrows pointing "down" were paired with yellow patches. The cards in decks #2, 3, and 4 were ordered in a semi-random, non-alternating fashion. Table 2 summarizes the characteristics and uses of the four decks of cards.

The remaining apparatus consisted of a 2 ft. square wooden base with a 2 ft. square vertical panel erected in the center

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[1]All the remaining stimuli to be described also involved cards with strips of tape mounted on them, the strips forming either color patches of the sort just described or arrows pointing in an "up" or "down" direction.

Table 2

Characteristics and Uses of the Card Stimuli

Card #	Type	No.	Make-up	Use
1	plastic	4	4 color patches (blue, red, yellow, green) arranged in different orders	test for color naming
2	3 x 5 in.	30	15 with arrow pointing "up", 15 with arrow pointing "down"	test for arrow naming; used as stimuli in transfer task
3	plastic	30	15 with arrow pointing "up" on left, red patch on right; 15 with arrow pointing "down" on left, blue patch on right	"relevant" pretraining
4	plastic	30	15 with arrow pointing "up" on left, green patch on right; 15 with arrow pointing "down" on left, yellow patch on right	"irrelevant" pretraining

of the base. In the middle of the vertical panel, a 3 x 5 in. piece of frosted glass was mounted. Behind this glass was located a single white seven watt bulb. On the section of the base facing the S were two switches mounted side by side and 10 in. apart. Both switches were covered with wooden knobs 5 1/2 in. in circumference. The knob on the S's left was red, the knob on his right blue.[2] The E could, by means of a selector switch on the back of the apparatus, set either one of the switches on the front to turn on the light. A switch was also available on the back for turning off the light.

[2]Strips of tape of the appropriate color were mounted on the knobs, the colors involved thus being identical to those used in card deck #3.

Procedure.- Tests for color and arrow naming.- Each S was run individually. With the button pressing apparatus and the other decks of cards out of sight, S was first presented with the cards in deck #1 and asked to name the four colors. The cards were presented manually by E in a vertical position. Those Ss who were able to respond correctly to all four cards (16/16 correct responses) or who could name the colors correctly in 30/32 responses (two presentations of the deck) were continued in the experiment; those Ss unable to meet the color naming criteria were excused from further participation.[3] Next, the S was shown the first two cards of deck #2 (one 3 x 5 in. card with an arrow pointing "up", one with an arrow pointing "down") and told that the one pointing "up" was called "up", the one pointing "down" was called "down". The S was asked to repeat the labels and then was presented the succeeding cards in the deck, one at a time, and was asked, "What do you call this?" This process was continued until S named ten consecutively presented arrows correctly.[4] Again, the cards were presented manually by E and in a vertical position, so that the "up" and "down" arrows did literally point up and down.

Pretraining.- Depending on whether he was a member of the Relevant or Irrelevant pretraining group, the S was next presented with card deck #3 (relevant) or #4 (irrelevant). The cards were presented manually in a vertical position by E, the pacing being determined by S's responses. The first card was

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[3] Four mongoloids and seven normals were dropped because of inability to meet the color naming criteria.

[4] Most Ss were able to meet this criterion in 10 trials. No S was unable to meet the arrow naming criterion and the largest number of trials needed was 22.

exposed and E said, "Now I want you to tell me what's on these cards. First tell me which way the arrow points, and then tell me the name of the color." The deck was then run through three times, the S thus making 90 paired responses to the two types of arrow-color combinations. It will be noted that Ss in the Relevant group were exposed to the combinations of "Up-Red" and "Down-Blue," whereas Ss in the Irrelevant group were exposed to the combinations of "Up-Green" and "Down-Yellow."[5] If naming errors occurred due to lack of attention or to premature responses made to about-to-be-exposed cards, E corrected S and had him name the pair correctly.

Transfer task.- At this point, the button-pressing apparatus was placed on the table before S. The E sat to the side of the table so that he could reach to both the front and back of the apparatus. The following instructions were recited:

> See this machine? It has two buttons on it. One is red (pointing), one is blue (pointing). The buttons can turn on a light up here (E points to the frosted glass). Sometimes this button turns the light on (E points to red button), sometimes this button turns the light on (E points to blue button). Now, I have some pictures here and they will tell you which button will turn the

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[5] Originally, it was planned to treat these as paired-associates, as the stimuli were handled in the Bugelski-Scharlock study. That is, only the left-hand stimulus would be exposed and the S would have to indicate which stimulus was on the right. Thus, Ss in the Relevant group, e.g., would have to learn to say "red" when the "up" arrow was exposed and "blue" when the "down" arrow was exposed. Pilot work with non-mongoloid defectives of the appropriate MA level at Letchworth Village indicated that this task would be too difficult for the mongoloid Ss. The pilot Ss were unable to understand the nature of the task in a reasonable number of trials. Thus, the "naming" procedure was resorted to in place of the more desirable "learning" procedure. The hope was, of course, that the Ss, in the process of making 90 paired responses (45 of each kind), would learn the combinations.

> light on. Each time I show you a picture, you look at it and then push the button you think will turn the light on. Remember, the picture will tell you which button turns the light on, so look at the picture first and then push the button you think will turn the light on.

The cards from deck #2 (30 3 x 5 in. cards - - 15 with "up" arrows, 15 with "down" arrows) served as the "pictures" referred to in the instructions. The cards were presented manually one at a time, propped against the vertical panel of the button-pushing apparatus and between the two buttons. The S was reminded to look at the picture if he started to press a button without doing so. In some cases, S had to be encouraged to press a button on the first few trials. The S was not allowed to push the "correct" button on any given trial if he had responded first by pushing the "incorrect" button. "Correctness" and "incorrectness" of the buttons were determined by E's setting the selector switch so that either the red or the blue button (but not both) could turn on the light. The red button was "correct" when the "up" arrow appeared, the blue button was "correct" when the "down" arrow appeared. The E said, "Good, you turned the light on" when S responded correctly, and "No, that wasn't the button" when S responded incorrectly. After each correct response, E turned off the light, using the switch on the back of the apparatus.

Predictions.- It was assumed that the Ss in the Relevant group would enter the transfer task with a tendency to respond "red" when exposed to an "up" arrow and "blue" when exposed to a "down" arrow, because of the nature of their pretraining (45 exposures

each of "up-red" and "down-blue"). The Ss in the Irrelevant group, on the other hand, were not expected to have this tendency, since their pretraining did not involve the colors red and blue. If the S were to respond, either implicitly or explicitly, with "red" to the "up" arrow and "blue" to the "down" arrow, then presumably such responses would direct their attention to the "correct" button on each trial.

On this basis, it was predicted that the Ss in the Relevant pretraining group would make significantly more correct responses on the 30 trials of the transfer task than would the Ss in the Irrelevant pretraining group. In addition, because of the intellectual superiority of the normals over the mongoloids, it was expected that the superiority of the Relevant over the Irrelevant group would be greater for the normal than for the mongoloid Ss.

Results

As mentioned previously, four mongoloids and seven normals were dropped from the study because of inability to meet the color naming criteria. In addition, two other mongoloids were dropped - - one because of being over-age, one because of a motor-speech disorder which rendered the task prohibitively long.

Table 3 presents the means and sigmas for number of correct responses on the transfer task. A factorial analysis of variance design was applied to these data; the results are summarized in Table 4.

Table 3

Number of Correct Responses on the Transfer Task

Group	Mean	SD
Mongoloid-Relevant	22.00	5.49
Mongoloid-Irrelevant	22.08	5.45
Normal-Relevant	21.00	7.02
Normal-Irrelevant	23.00	5.12

Table 4

Results of Analysis of Variance Applied to the Transfer Task Data

Source	df	Mean Sq.	F
Relevant vs. Irrelevant	1	10.03	<1.00
Mongoloid vs. Normal	1	.02	<1.00
Interaction	1	10.01	<1.00
Error	40	33.47	<1.00
Total	43		

Tables 3 and 4 indicate that the results were uniformly negative - - neither main effect was significant, nor was there a significant interaction between type of pretraining and type of subject.

Discussion

Three alternative interpretations of the negative results are more or less tenable. First, one may argue that the Ss did acquire tendencies to respond with the appropriate color names as a result of the pretraining. For Ss in the Relevant group this would involve the "up-red" and "down-blue" associations,

while for Ss in the Irrelevant group this would involve the "up-green" and "down-yellow" associations. Assuming such learning did occur, it would follow that the presence of the appropriate mediating responses in the Relevant group Ss (i.e., "red" and "blue") had no effect upon their performance in the transfer task. In view of the extensive array of evidence supporting the role played by mediating responses in such situations (1, 2, 3, 10), however, a more plausible interpretation would be that the Ss, despite 45 repetitions of each of the arrow-color combinations during pretraining, did not acquire any appreciable amount of habit strength involving the associations and thus the mediating responses did not occur with any degree of reliability in the transfer task situation. Unfortunately, the Ss were not asked to show whether or not they had acquired the associations, though a few demonstrated through spontaneous verbalizations that they had.

A third possible interpretation might involve the notion that both treatment groups (Relevant and Irrelevant) entered the transfer task situation with names for the arrow stimuli (by virtue of the pretraining) and that the possession of these names facilitated the performances of both groups, with the result that any advantage the Relevant group Ss might have had was washed out. This effect is known as the "acquired distinctiveness of cues" (7). While such an explanation cannot be ruled out, it is rendered suspect by the relatively low mean scores achieved by all four sub-groups. Had the arrow-name learning been facilitative, one would h ve expected considerably higher mean scores on the transfer task.

In any repetition of a study such as this one, training to a paired-associates learning criterion would seem to be mandatory, so that the second interpretation given above could be ruled out. Essentially, the "naming" rather than the "learning" procedure was used because of time limitations. The fact that a paired-associates task appeared to be so difficult for defective pilot Ss with MA's comparable to those of the Ss used in the present study indicates that a great deal needs to be learned about how one may teach simple paired-associates to low-trainable defectives in reasonably brief periods of time. In order to actually test for the presence of the "acquired distinctiveness" effect (the third interpretation listed above), an additional control group of Ss not exposed to the arrows prior to the transfer task would have to be run.

Summary

Twenty-four mongoloids (mean CA = 20 yr., 10 mo., mean MA = 5 yr., 3 mo., mean IQ = 35) and 20 normals (mean CA = 5 yr., 6 mo., mean MA = 5 yr., 5 mo., mean IQ = 100) served as Ss in this experiment. Half of each group (Relevant sub-groups) were presented with 90 paired presentations of arrow and color stimuli - - 45 with an arrow pointing "up" paired with red, 45 with an arrow pointing "down" paired with blue. The remaining Ss (Irrelevant sub-groups) were given the same treatment, except that the colors green and yellow were used, rather than red and blue. In each case, the S's task was to recite the names of the stimuli involved ("up-red" or "up-green" and "down-blue" or "down-yellow"). Following this pre-training, all Ss were given the same transfer task involving

a two-button psychomotor problem. The S's task in the transfer situation was to learn to push a red button in response to exposures of an arrow pointing "up" and a blue button in response to exposures of an arrow pointing "down". "Correct" responses resulted in a light being turned on. It was expected that the Ss in the Relevant groups would carry a facilitative mediating response from the pretraining to the transfer task, whereas this would not be true of the Ss in the Irrelevant groups. It was further expected that the facilitative effect would be greater for the normal than for the mongoloid Ss.

The results showed no difference on the transfer task between Ss given the two types of pretraining or between the normal and mongoloid Ss; also, the interaction between type of training and type of subject was nonsignificant. Three alternative interpretations of the results were examined, the most likely one being that the Ss, despite 45 presentations of the two pairs of stimuli during pretraining, acquired little or no habit strength for the associations involved. Appropriate controls which would allow for an unambiguous interpretation of results in a replication of the study were indicated.

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FINAL COMMENTS

By way of conclusion, the authors would like to comment on the range of behavioral characteristics observed in the mongoloids who served as Ss in these studies. Behavioral variability was not particularly noticeable in the institutionalized mongoloids, as one might expect; but the stereotype of a docile, compliant, well-behaved individual did not hold up among the special class mongoloids. While some of these latter Ss did indeed appear to conform to this expected pattern, others evidenced behavior which could be described as hyperactive, hostile, rebellious, or all of these.

With specific reference to the discriminative behavior of the mongoloids, study #1 seems to call into serious question their reputed skill in rhythmic activities. From a theoretical and practical standpoint, the failure to obtain a facilitative effect from the tapping is interesting. Further research on this matter seems indicated, since such techniques are commonly employed in the classroom as presumed facilitators. Study #2, while indicating the inferiority of mongoloids relative to normals of the same MA in forming discriminative sets, the study does demonstrate that mongoloids can and do form such sets. How one may speed up the acquisition process and how one might best capitalize on whatever sets the severely retarded child possesses remain challenging problems for further research. The negative results of studies #3 and #4 indicate that a good deal of normative information is needed regarding the appropriateness of tasks, instructions, etc., for individuals (both normal and sub-

normal) with MA's in the ranges studied in these experiments.

Finally, some general comments on comparative research in mental retardation would seem to be appropriate. In his "Discussion" section in study #2, Mr. Girardeau pointed out that comparable MA's in a mongoloid and a normal child are likely to mean very different things, factorially speaking. In addition, groups of mongoloids and normals of the same MA level differ markedly in CA and in varieties of life experiences. Any such group comparison (mongoloid-normal, endogenous-exogenous, etc.) carries with it a very strong likelihood that several differences are confounded with the difference supposedly under investigation. Thus, in studies #1 and #2, one cannot conclude that the obtained differences were due solely to the fact that one group was mongoloid and the other normal. Historically, researchers using such comparison groups have tended to ignore this problem. Despite the complexities introduced ~~by those considerations,~~ it would ~~seem~~ be worthwhile to continue the utilization of the comparative approach. It remains the investigator's obligation, however, to attempt to control for as many variables as possible and to be aware of those that must necessarily remain uncontrolled.*

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*The writers have been stimulated to a consideration of problems inherent in comparative research in mental retardation by discussions on the topic with Dr. Thomas McCulloch, of the Research Department, Letchworth Village, Thiells, N.Y.